Contingency Evaluation

Transportation Systems 2004 Workshop

"Supporting DOD Operations Worldwide"

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Structural Suitability in a Contingency Environment

- **Units Tasked to Conduct Contingency Evaluations and Lessons Learned**

  Mr. Richard Smith
  Air Force Civil Engineering Support Agency (AFCESA)

- **Procedures for Structural Assessment of Contingency Airfields**

  Mr. Richard Smith
  Air Force Civil Engineering Support Agency (AFCESA)

- **Equipment Technology for Pavement Assessment**

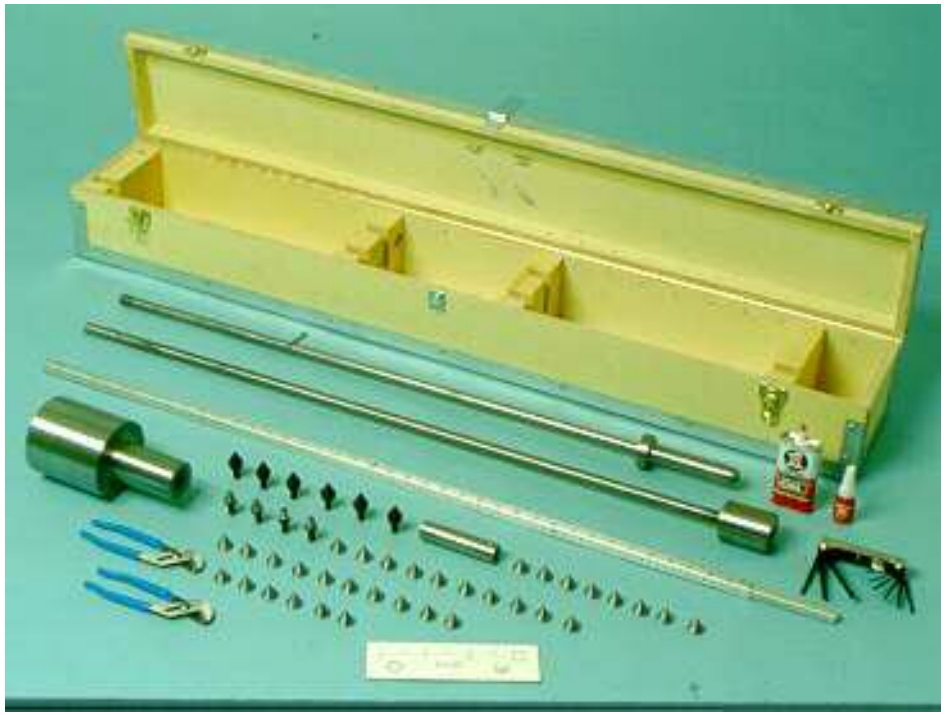
  Mr. Don R. Alexander
  US Army Engineer Research and Development Center (ERDC

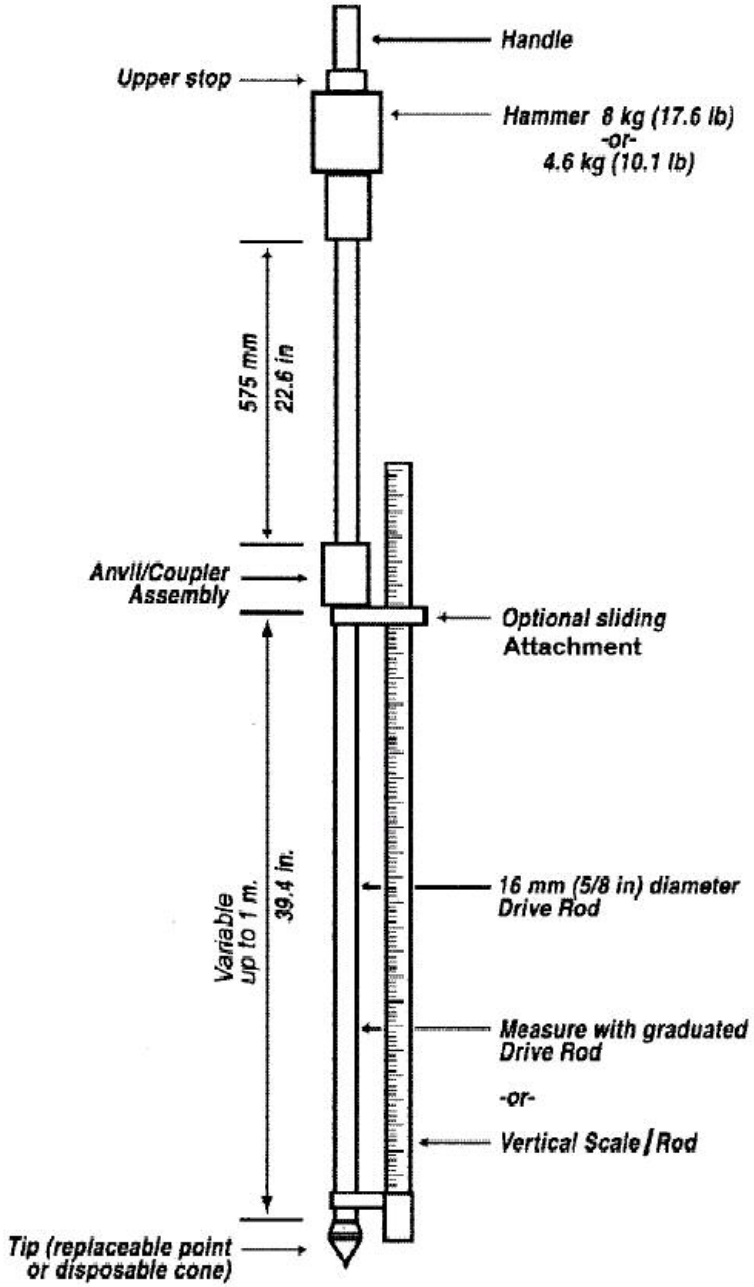
Dynamic Cone Penetrometer (DCP)

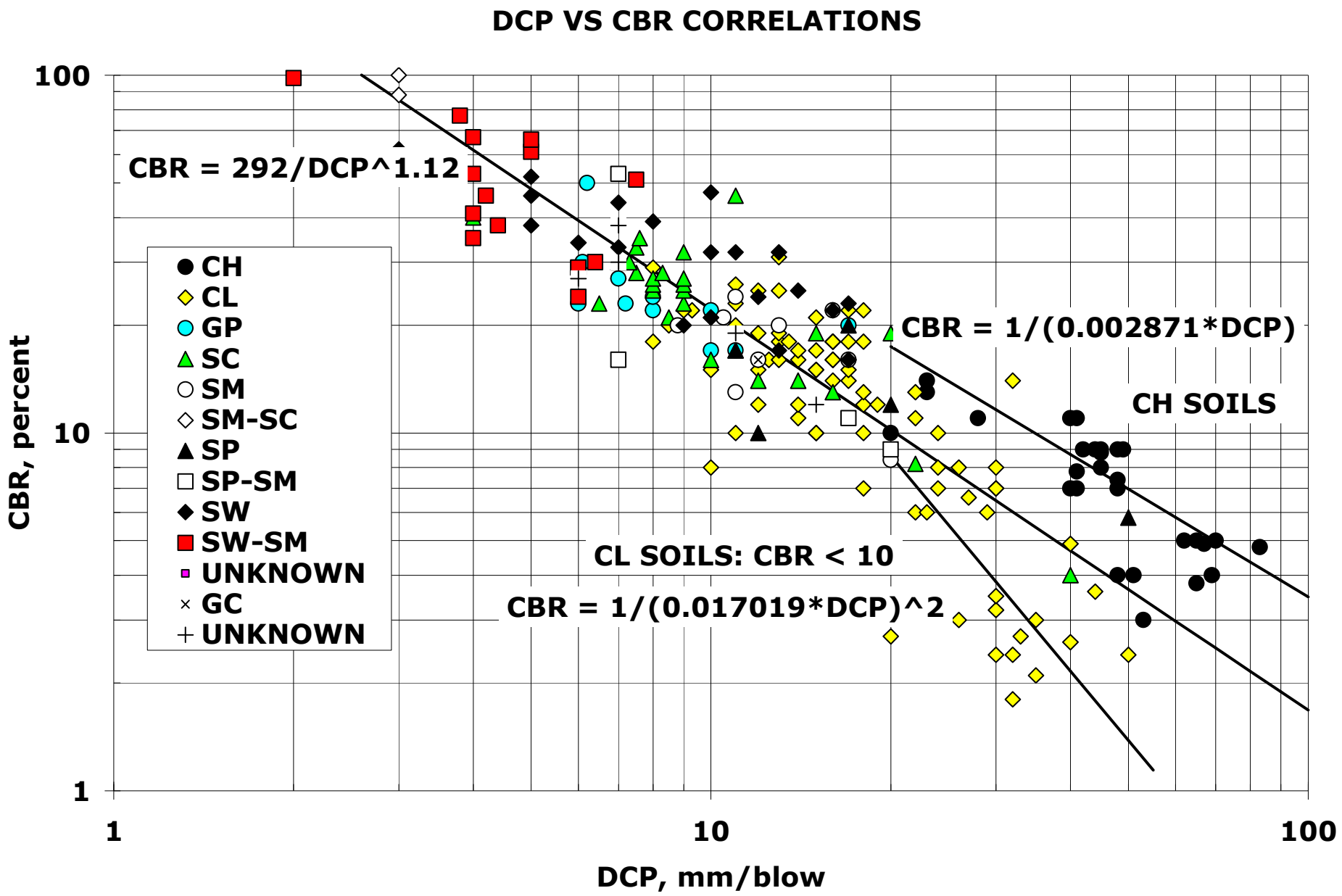
- Simple Device, Easy to Use
- No Electronics/Batteries Required
- Capable of Penetrating Stiff Layers
- Correlations Established For Estimating CBR

Designation: D 6951 – 03

Standard Test Method for Use of the Dynamic Cone Penetrometer in Shallow Pavement Applications[1]






DCP VS CBR CORRELATIONS
CBR, percent
DCP, mm/blow
100
10
1
1
10
100
CBR = 292/DCP^1.12
CBR = 1/(0.002871*DCP)
CH SOILS
CL SOILS: CBR < 10
CBR = 1/(0.017019*DCP)^2
CH
CL
GP
SC
SM
SM-SC
SP
SP-SM
SW
SW-SM
UNKNOWN
GC
UNKNOWN

Dynamic Cone Penetrometer (DCP)

Blows	Penetration
0	0
3	1.6
3	3.9
3	5.8
3	8.2

APE Evaluation

DCP - UFC Manual 3-260-3 Page 3-6

DCP DATA SHEET

Project: MAYPORT
Site: STATION R-550L
Test Location: R1A
Date: 12/5/01

Number of Blows	Accumulative Penetration (mm)
0	23
10	55
10	86
10	115
10	147
10	180
10	212
10	245
10	276
10	306
5	326
5	350
5	377
5	414
5	455
5	490
5	529
5	567
5	602
5	641
3	678
3	717
3	757
3	808
3	858
3	904
3	959
3	1010
3	1063
3	1109
3	1159
3	1208

Project: MAYPORT
Site: STA-550R
Test Location: R1A
Date: 12/5/01

Number of Blows	Accumulative Penetration (mm)
0	25
10	54
10	85
10	115
10	144
10	183
10	210
10	243
10	278
10	307
5	325
5	347
5	378
5	411
5	451
5	491
5	531
5	565
5	608
5	645
3	678
3	720
3	750
3	800
3	853
3	900
3	950
3	1008
3	1060
3	1111
3	1161
3	1211

Project: MAYPORT
Site: STA-550C
Test Location: R1A
Date: 12/5/01

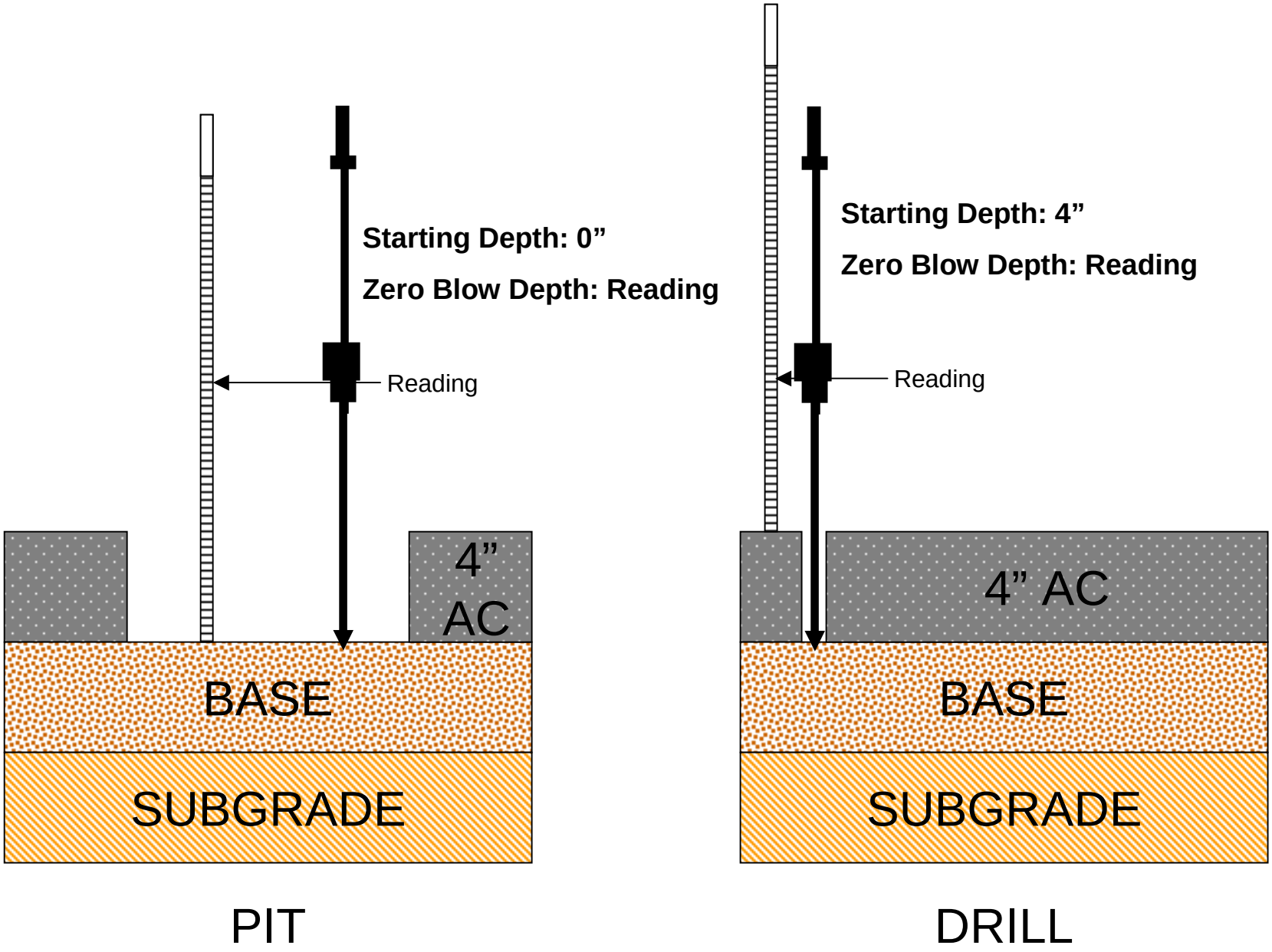
Number of Blows	Accumulative Penetration (mm)
0	26
10	58
10	91
10	123
10	152
10	185
10	220
10	252
10	264
10	280
5	330
5	360
5	385
5	420
5	461
5	485
5	535
5	572
5	610
5	651
3	685
3	725
3	763
3	815
3	865
3	911
3	963
3	1017
3	1070
3	1115
3	1165
3	1212

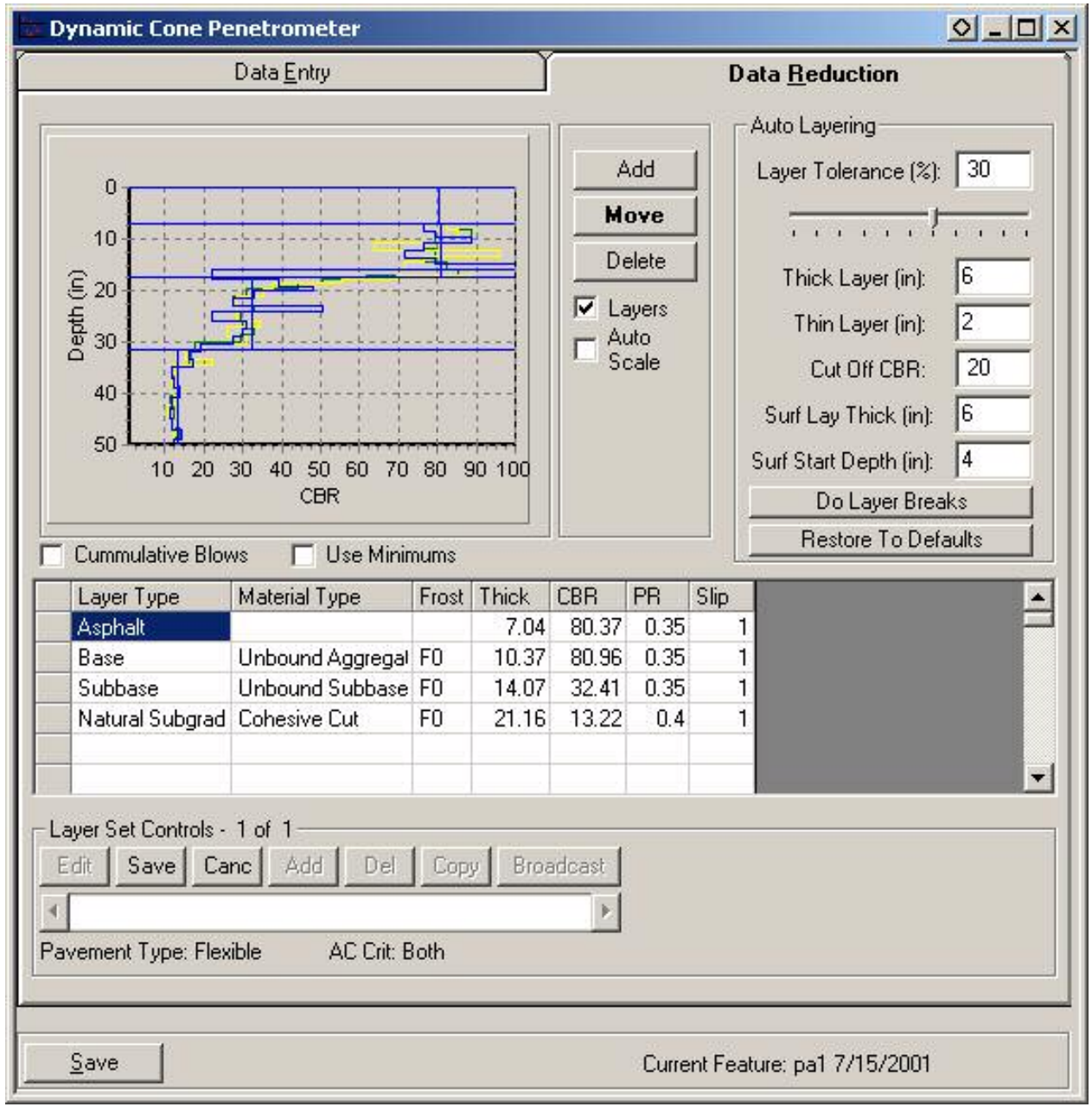
Perform Field Tests Automated DCP

Latest version of DCP, developed to facilitate evaluation of semi-prepared airfields for C-17 operations, reduces manpower required to perform to one person.

Manual operation

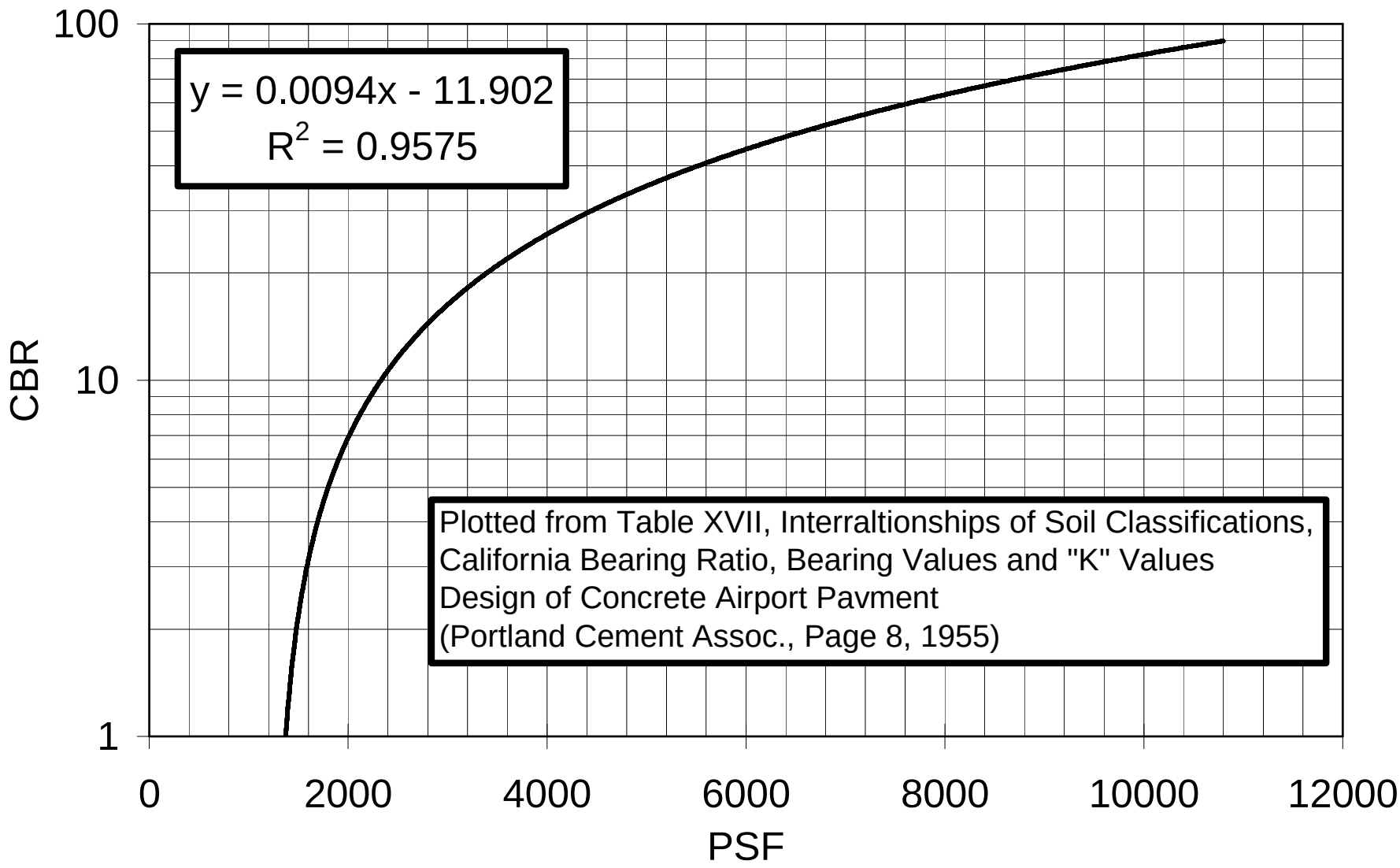
Automated data collection


Starting Depth: 0”
Zero Blow Depth: Reading
Reading
4”
AC
BASE
SUBGRADE
PIT
Starting Depth: 4”
Zero Blow Depth: Reading
Reading
4” AC
BASE
SUBGRADE
DRILL



DCP - UFC Manual 3-260-3 Page 3-6 & 3-7

CBR VS BEARING VALUE



Larger Devices (Poor Logistics)

- Automated DCP
  - Layer thickness
  - Layer Strength
- Electronic Cone Penetrometer
  - Layer thickness
  - Layer Strength
- Falling Weight Deflectometer
  - Pavement stiffness
  - Material properties (moduli)
- Ground Penetrating Radar
  - Layer Thickness
  - Underground utilities
- Ladar
  - Rut Depth
  - Roughness

Perform Field Tests Automated DCP Truck

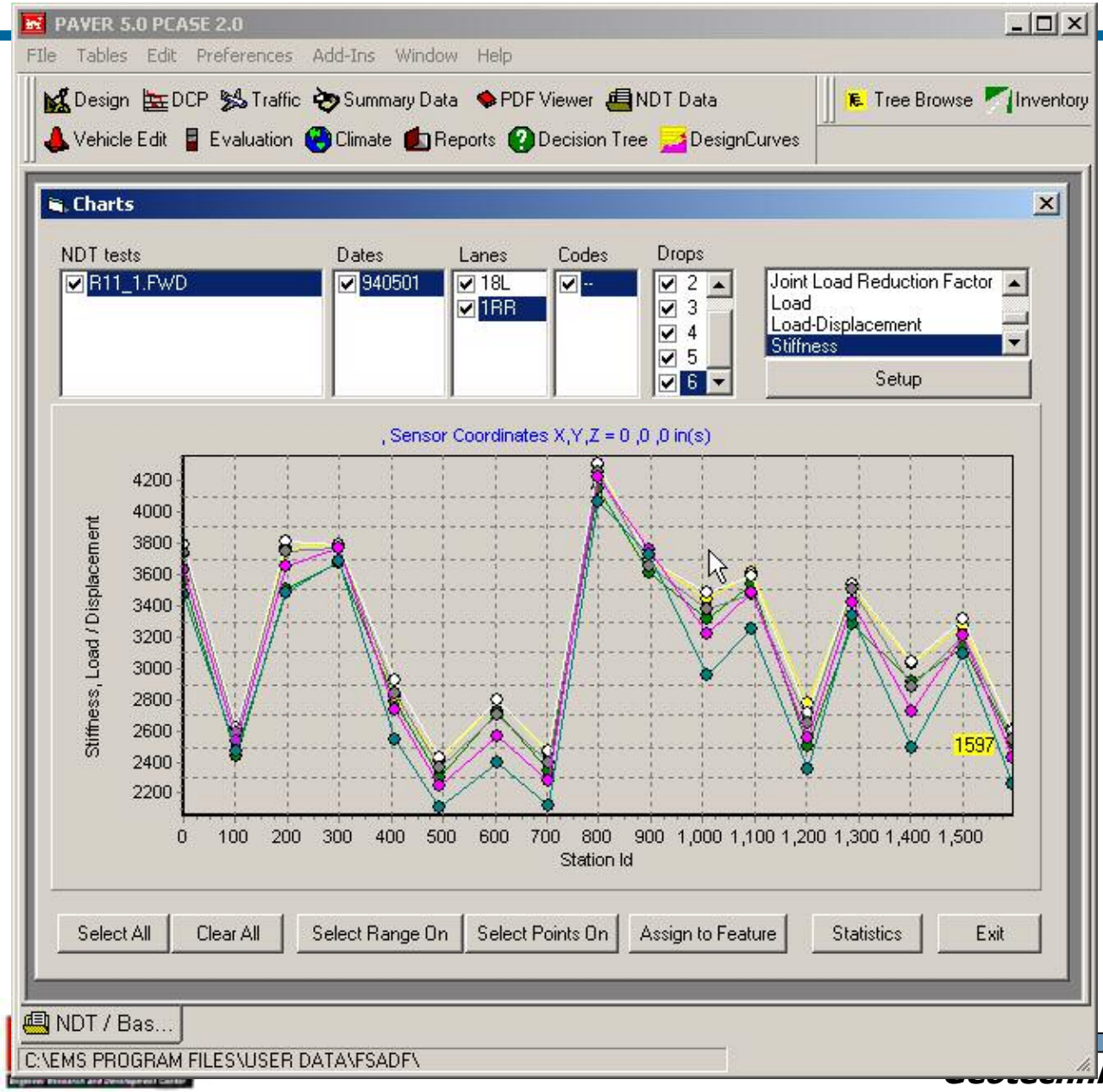
- Automatically operated hammer drives tip into soil
- Correlates to CBR

Perform Field Tests Electronic Cone Penetrometer

- ECP correlation classifies soil type and layer thickness & strength
- Typically penetrate 5 – 10 feet

Falling Weight Deflectometer

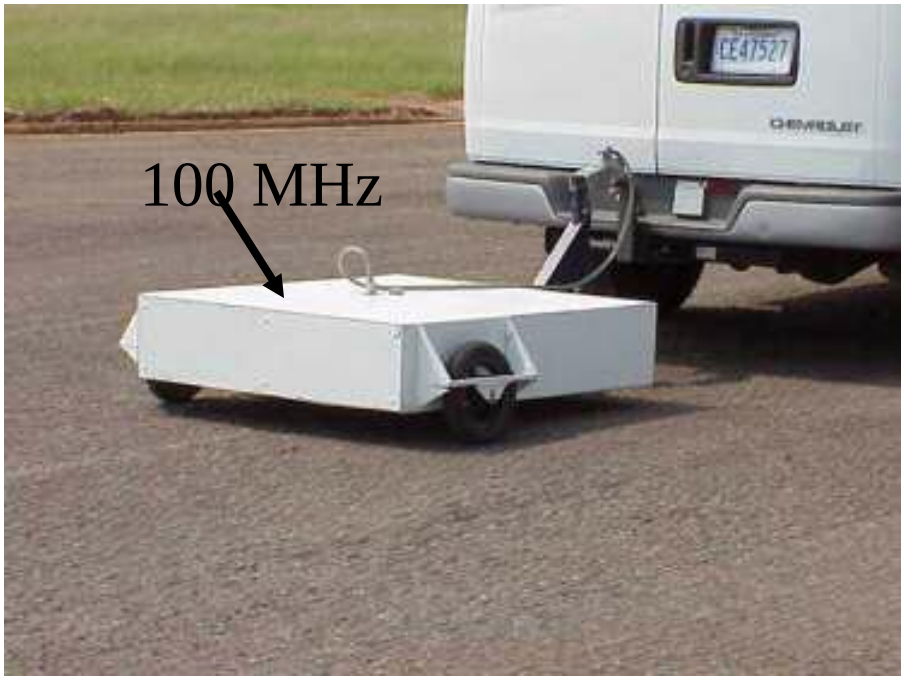
NDT



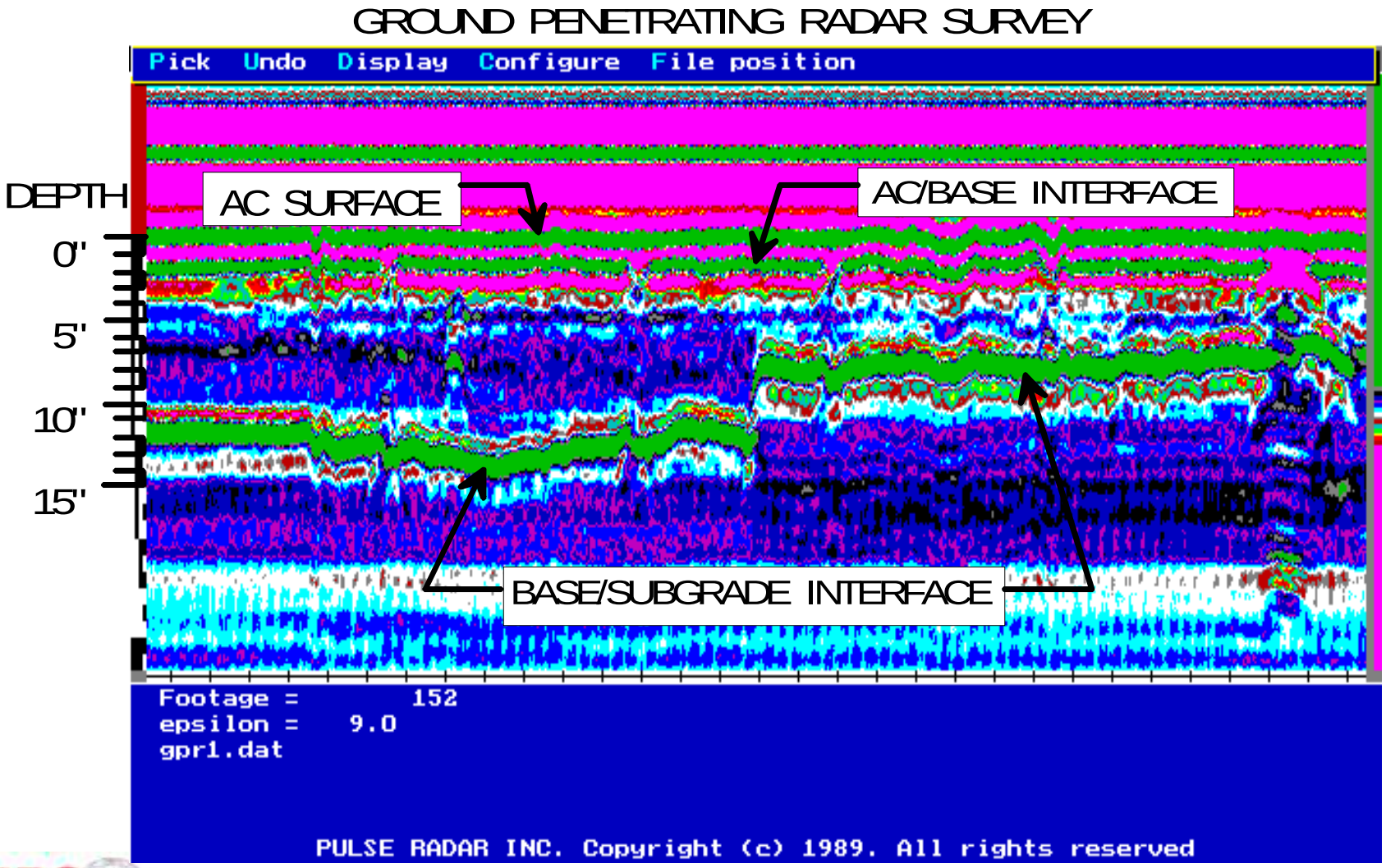
- Analyzing test data using various plots
- Assigning Test Data to Feature
- Statistics
- Multiple Drop/Lane filtering

Ground Penetrating Radar

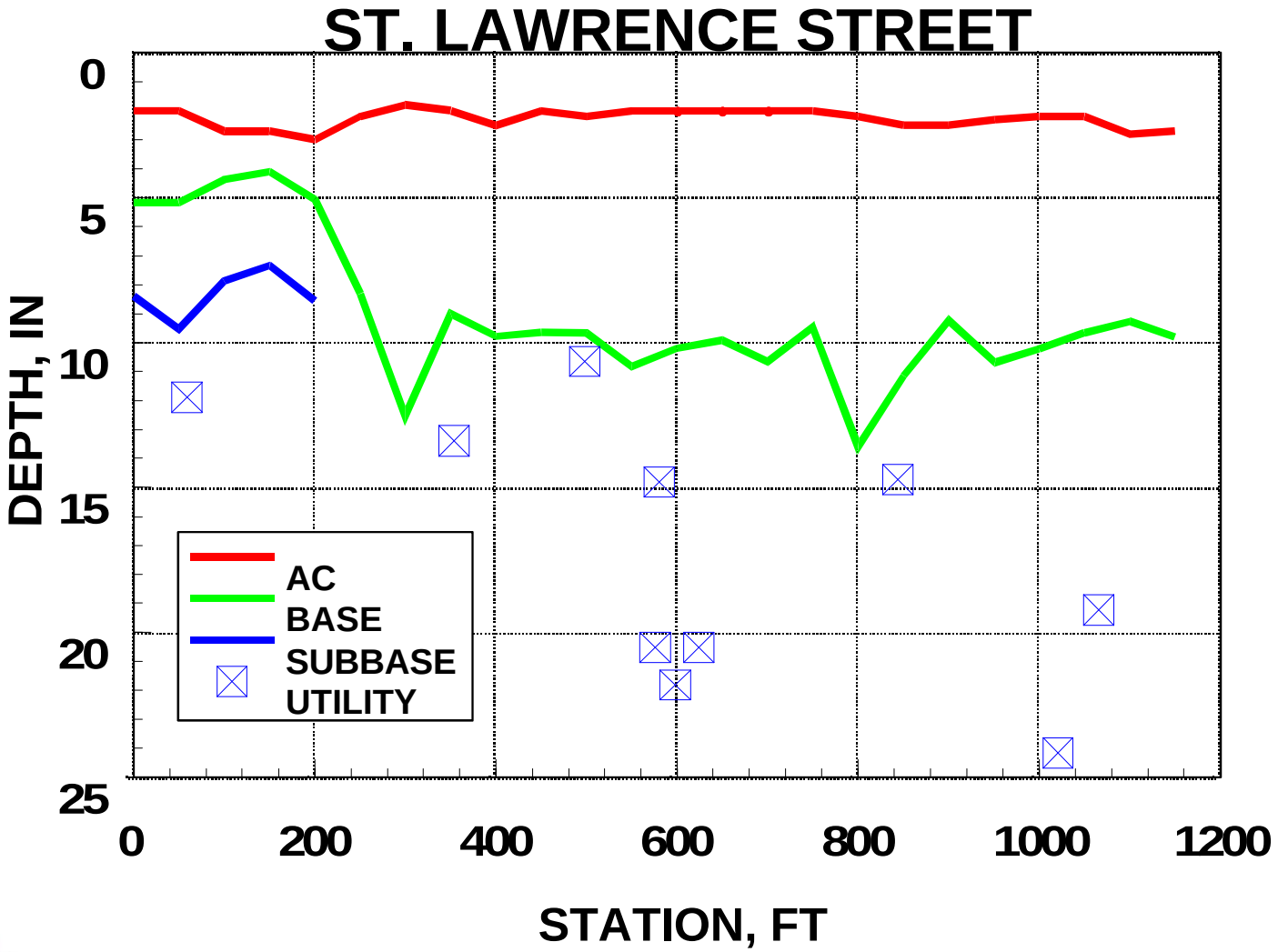
Developed by
Pulse Radar, Houston, TX
under SBIR Contract
(Two Systems Delivered to WES)



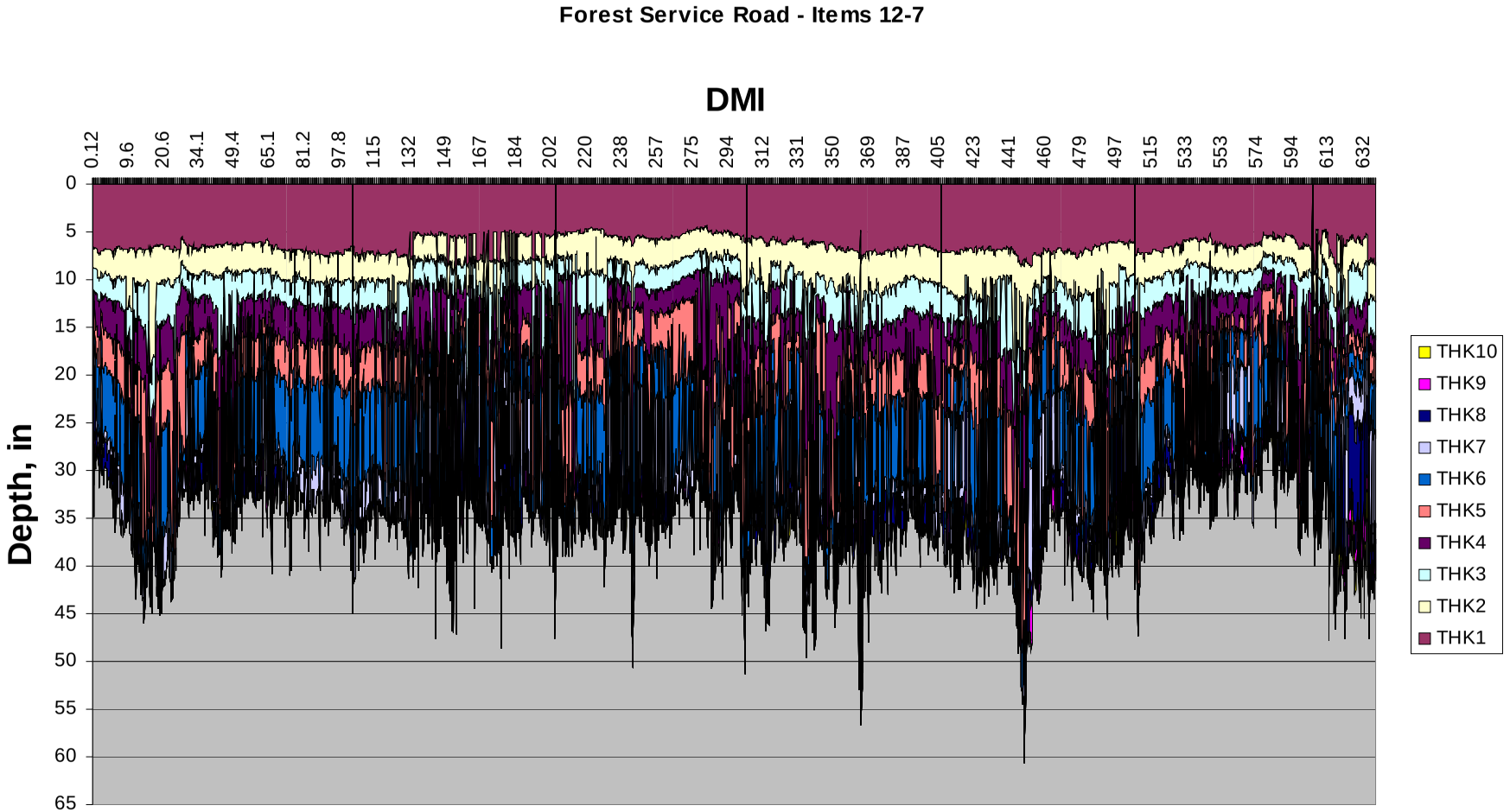
Color Coded GPR Signal



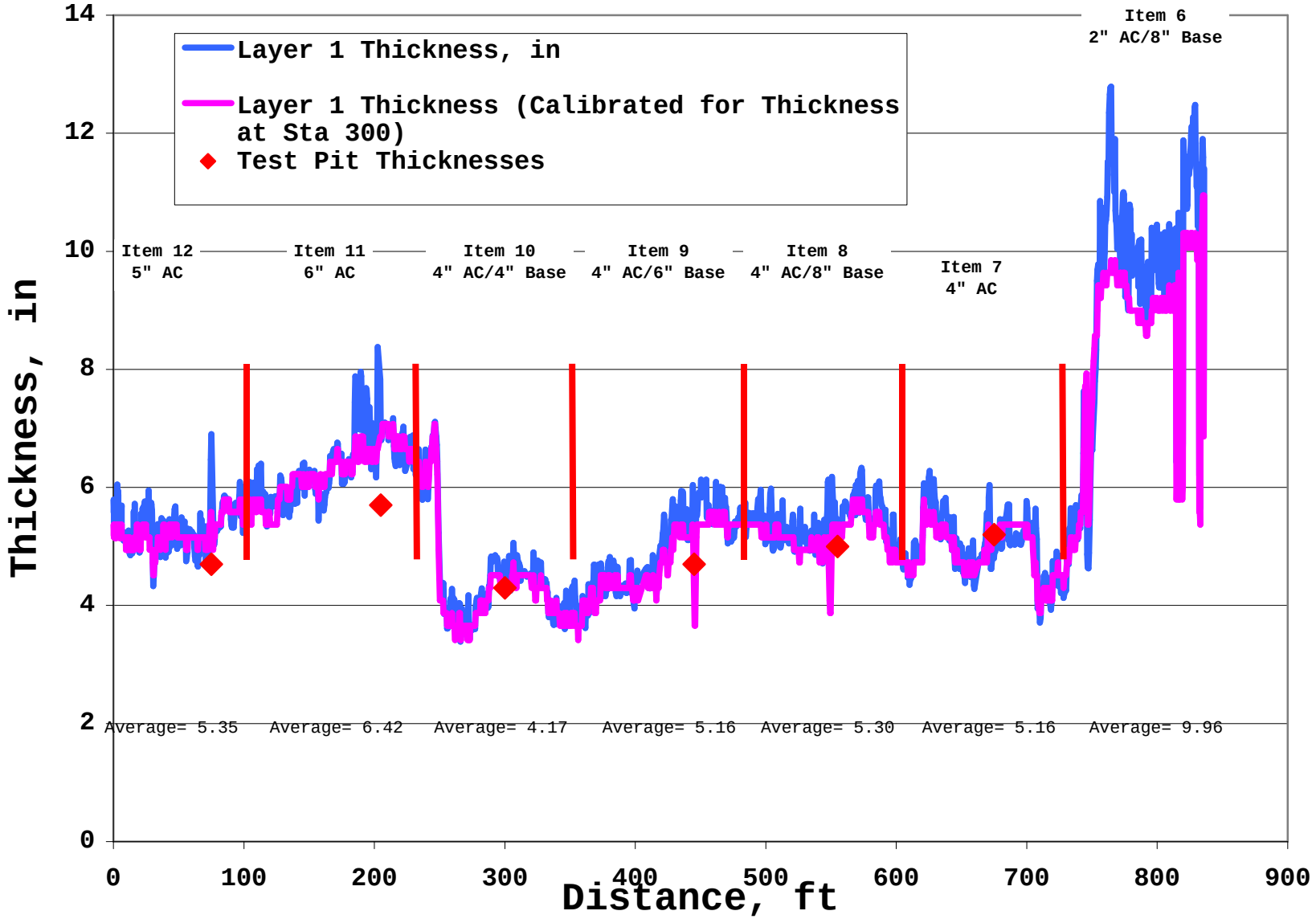
GPR Survey of Road at WES



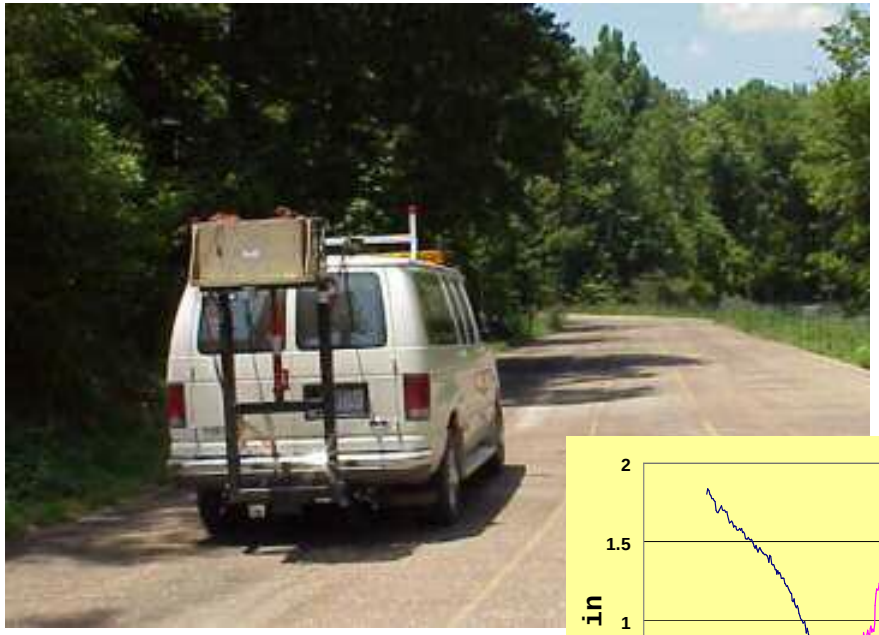
Depth (Thickness)



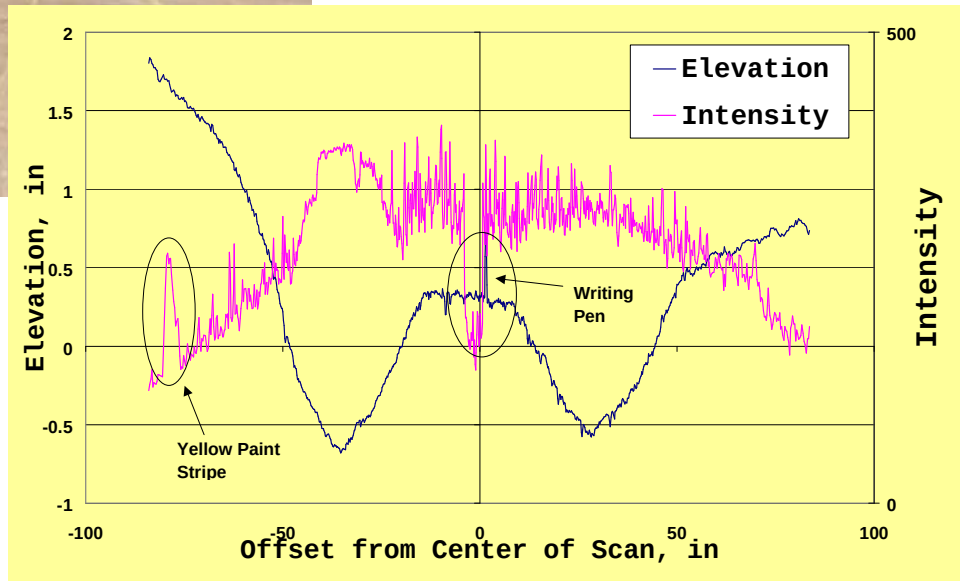
Ground Penetrating Radar

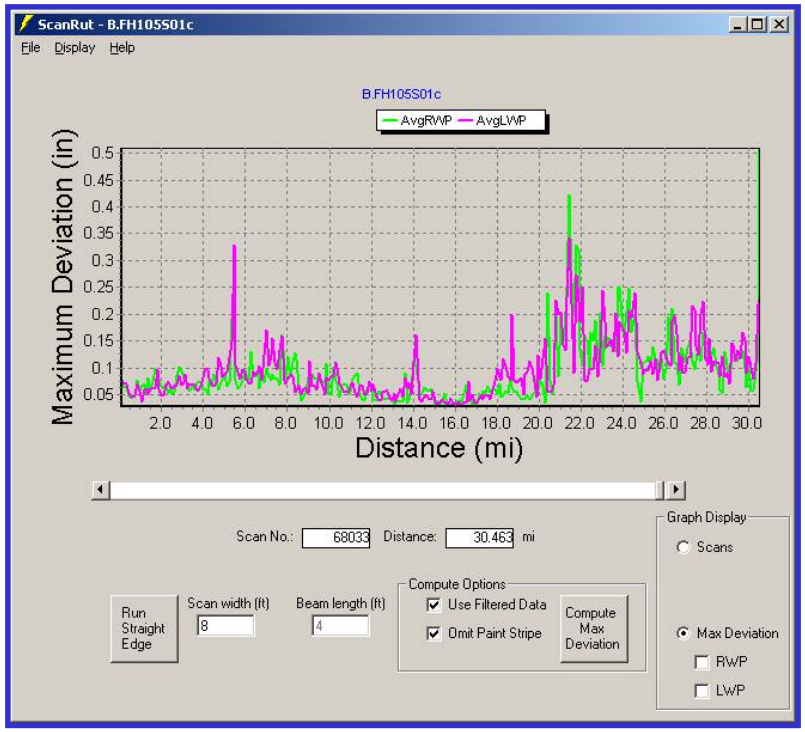


Phase-Measurement Laser Radar (Ladar)

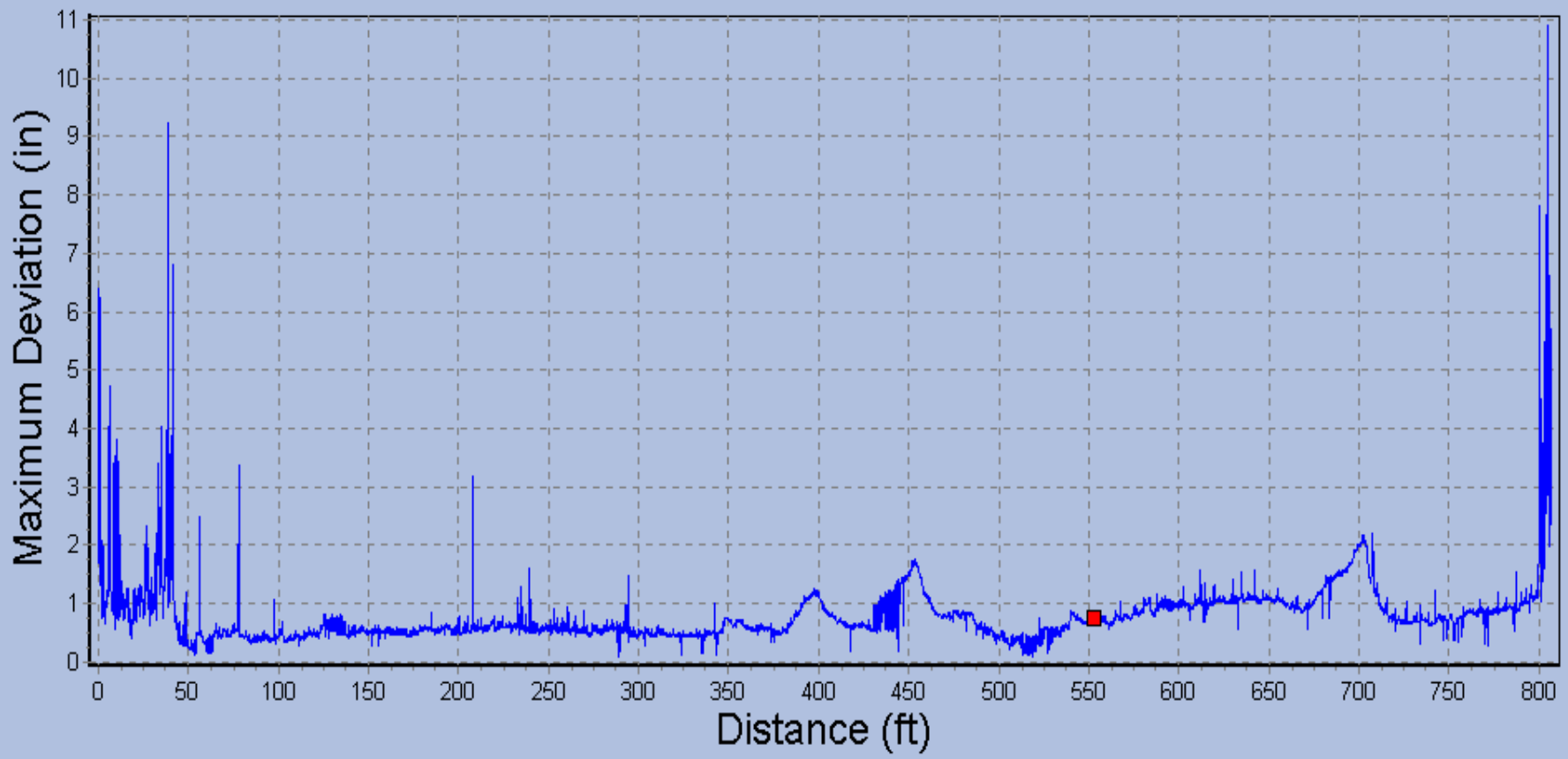


The Airfields and Pavements Branch of the Engineer Research and Development Center is developing applications for a new measurement sensor developed under an Army SBIR by Phoenix Scientific, Inc. (PSI)





Road Survey – GPR, Ladar, ARRK



Scan width (ft)
12

Scan No.: 3732

Distance: 553.3

Avg el: 2.7554

Diff el:

Graph Display
- Scans
- Max Deviation

Distance Scale Factor: 0.04946984

Ref. Scan number: 1

Ref. Station: 0

Run Straight Edge

Avg el: for scan

Set Baseline Avg

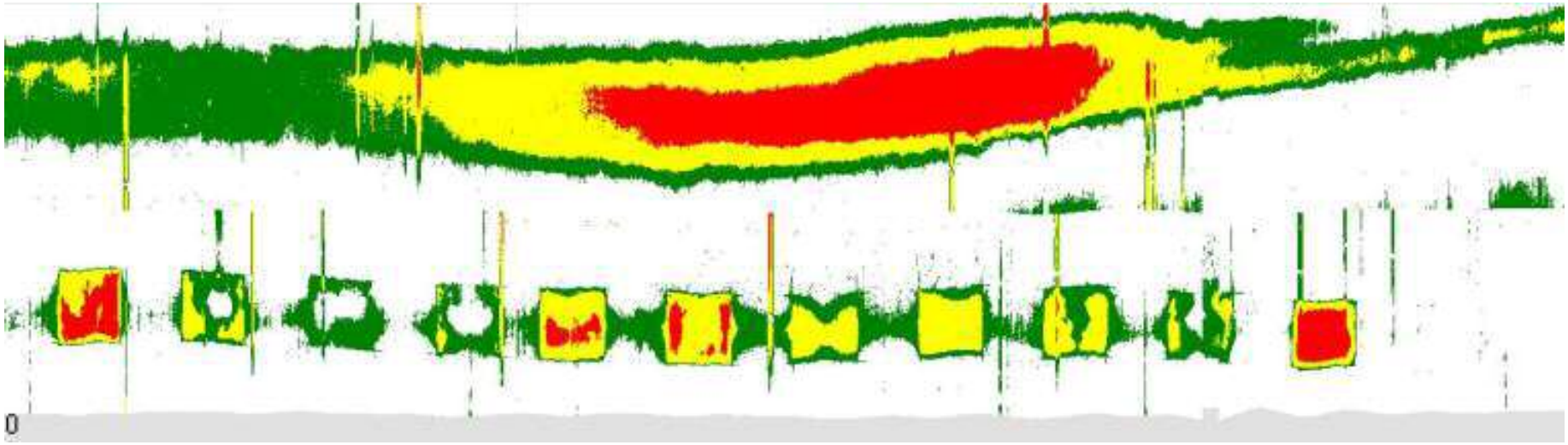
Get deflection as offset for all traces

Ref. File:

Shift: 0

Compute Max Deviation

Phase-Measurement Laser Radar (Ladar)



Smaller Devices Under Development/Testing

- Geogauge
  - Pavement stiffness
- Portable Falling Weight Deflectometer
  - Pavement stiffness
- Portable Seismic Test Equipment
  - Layer thickness (top layer)
  - Modulus (top layer)
- Extended PSPA
  - Layer thickness (top meter)
  - Modulus (top meter)
- Free-Free Resonance Testing
  - Modulus (core)

GeoGauge – Stiffness & Modulus

GeoGauge

Humboldt GeoGauge:

Physical Attributes

- Size: 11" OD x 10" tall
- 4.5" OD x 3.5" ID Foot
- Weight: 22 lb
- Powered by 6 D-Cell Batteries
- Keypad User Interface

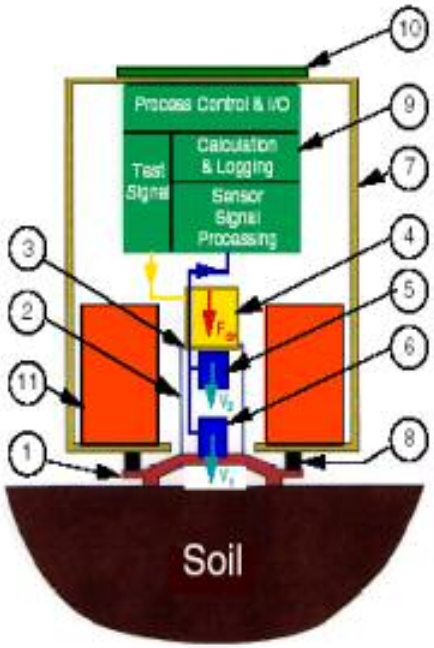
Specification

- Stiffness: 3 (17) to >70 (399) MN/m (klb/in)
- Young's Modulus: 26.2 (3.8) to > 607 (88) MPa (kpsi)
- Poisson's Ratio: Variable in 0.05 Increments
- Precision: Typically 3.9% Coefficient of Variation
- Bias: < 1: Coefficient of Variation
- Depth of Measurement: 22.9 cm (9 in)
- Battery Life: >1500 measurements
- Operating Temperature: 0 C to 38 C (32 F to 100 F)

GeoGauge

Operating Principle

- Stiffness to Modulus (Young's, E)
  - Measures Stiffness
  - Through Foot Radius and Poisson's Ratio Obtain Modulus



1 Rigid foot with annular ring
2 Rigid cylindrical sleeve
3 Clamped flexible plate
4 Electro-mechanical shaker
5 Upper velocity sensor
6 Lower velocity sensor
7 External case
8 Vibration isolation mounts
9 Electronics
10 Control & display
11 Power supply

$E(MPa) = P*(1-v^2)*b/r/d$
where
P/d = the SSG stiffness reading (MN/m)
v = Poisson's ratio (assumed to be 0.35 for all materials tested)
r = radius
b = 2*a/Π (a = 0.89 for a rigid ring with radius ratio = 1.3)

Portable Falling Weight Deflectometer

Devices Evaluated - PFWD

Keros Prima 100 Portable Falling Weight Deflectometer:

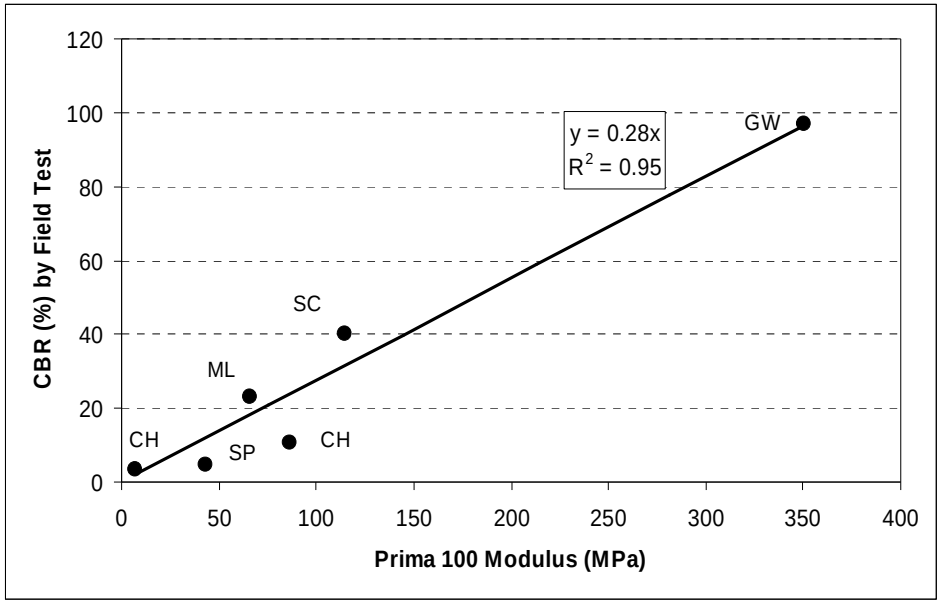
Physical Attributes

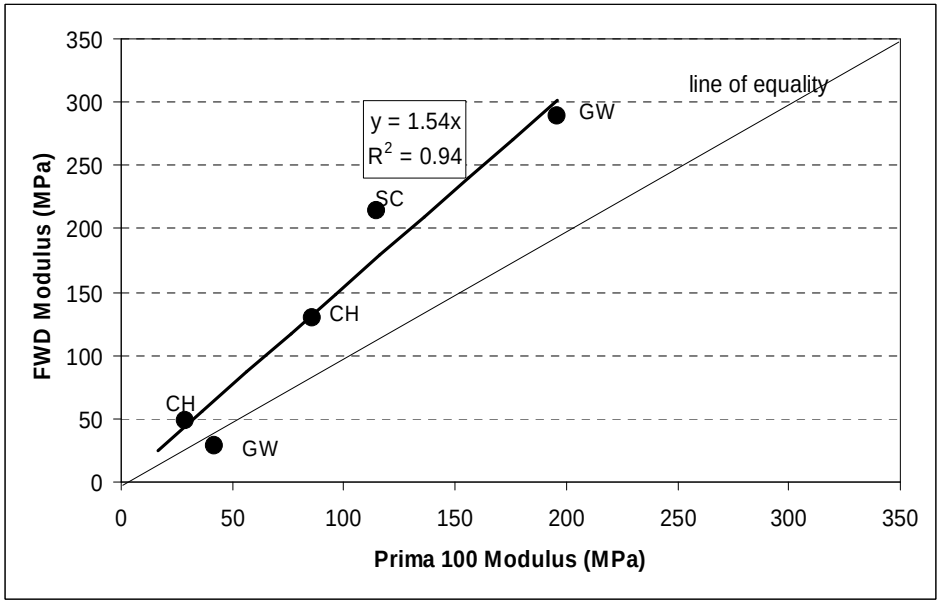
- Weight: 26 kg
- 10-20 kg Falling Mass
- Adjustable Falling Height of 0-850 mm
- Adjustable Falling Mass of 10, 15, or 20 kg

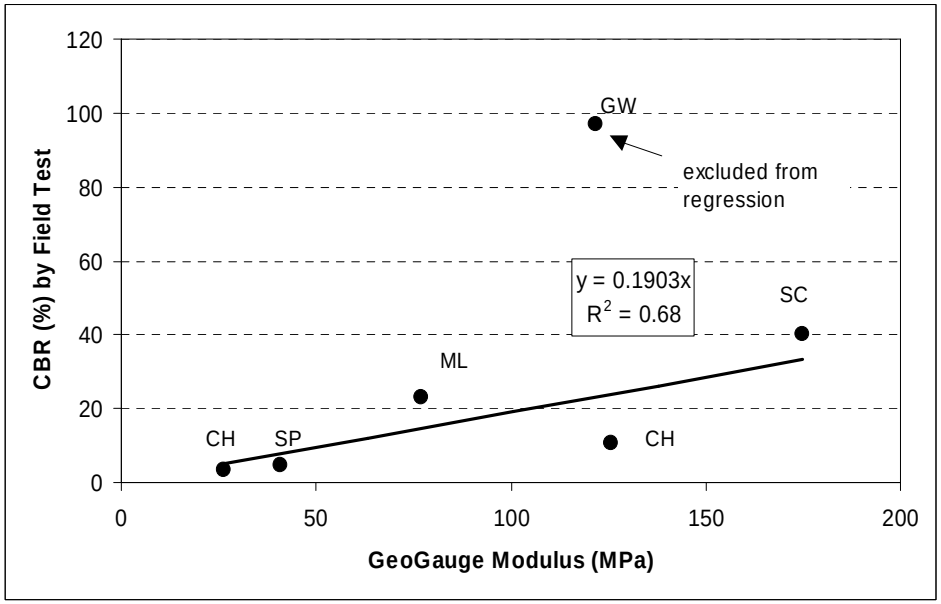
Specification

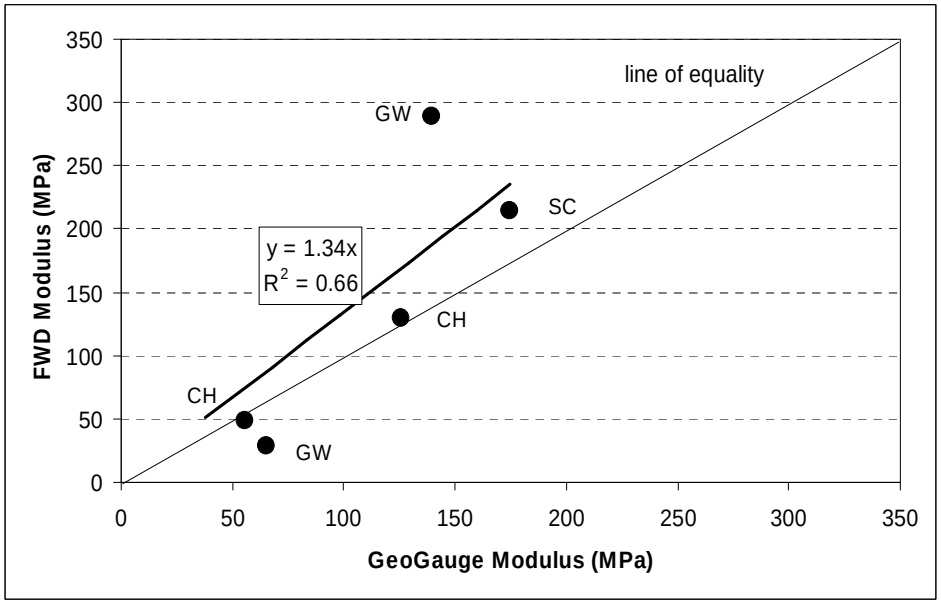
- Selection of Loading Plate
  - 300 mm: Subgrade, earth filling, subbase, gravel base layer
  - 200 mm: gravel base layer, weak road structures
  - 100 mm: Strong road structures
- Operating Temperature: 5 C to 50 C (41 F to 122 F)
- Expected Measuring Range Modulus (Young's, E)
  - Subgrade: 5-60 MPa
  - Subbase: 25-75 MPa
  - Gravel Base Layer: 40 - 125 MPa
  - Asphalt: 100-300 MPa

Preliminary Results

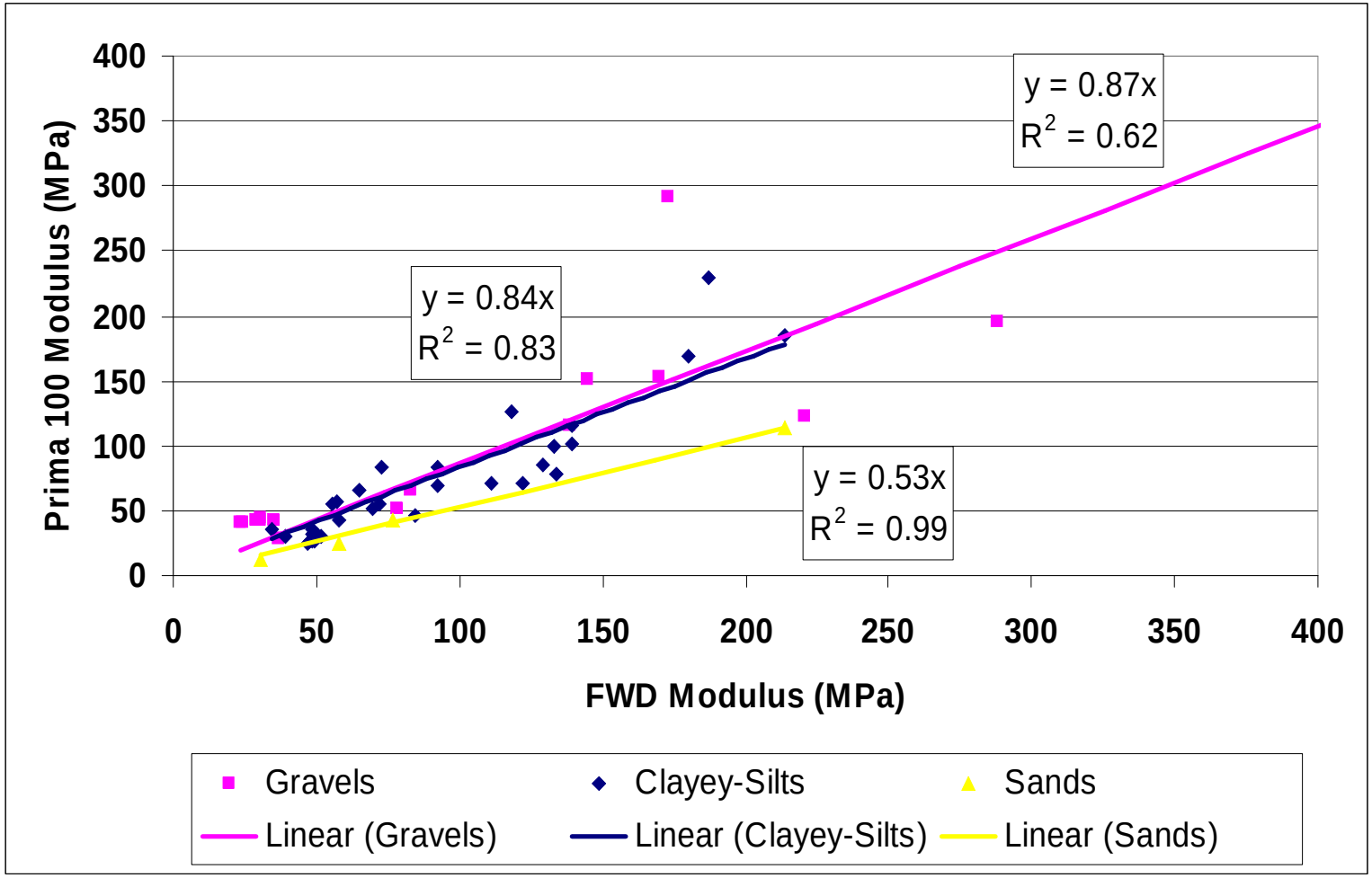




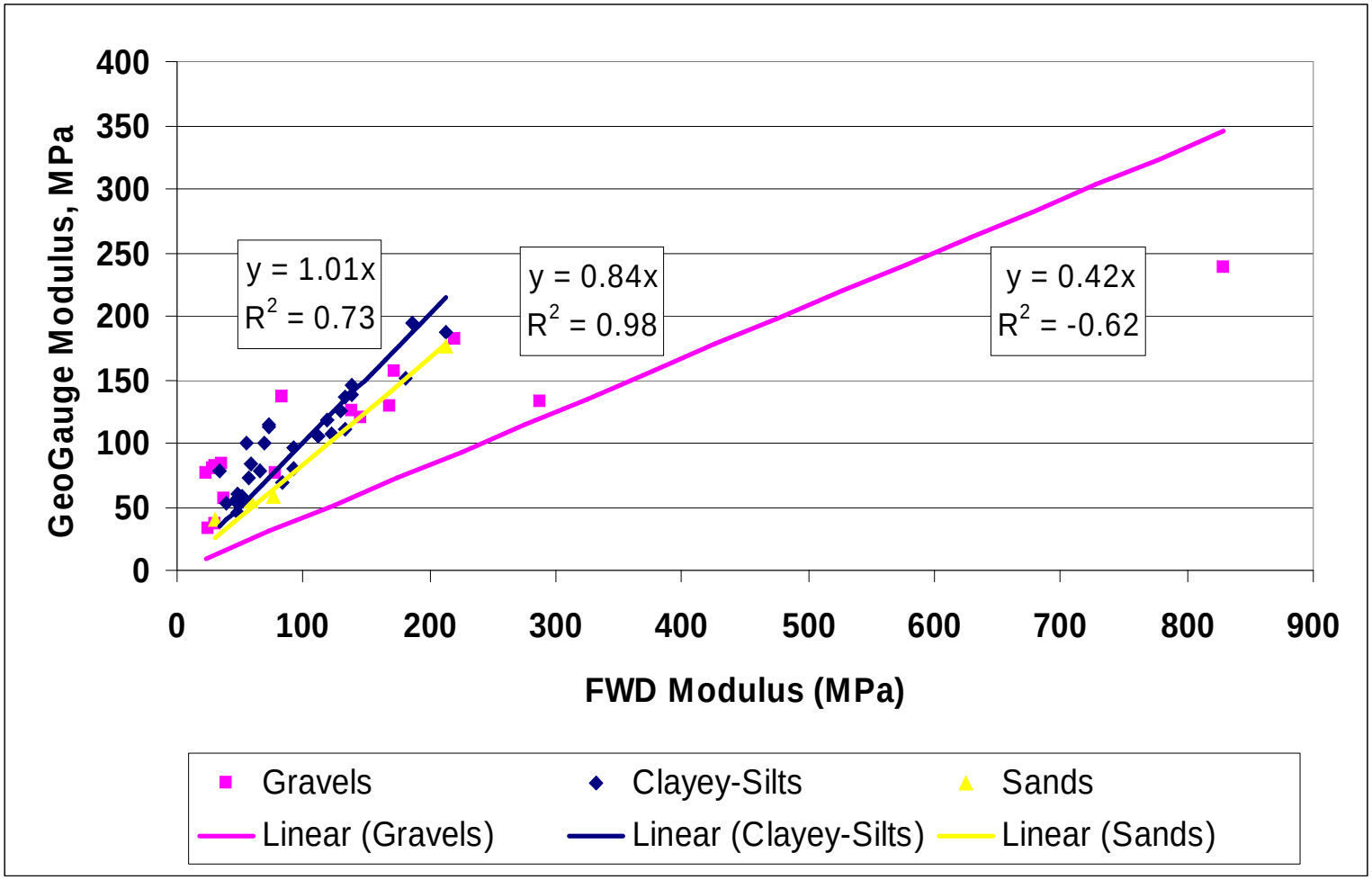




Preliminary Results

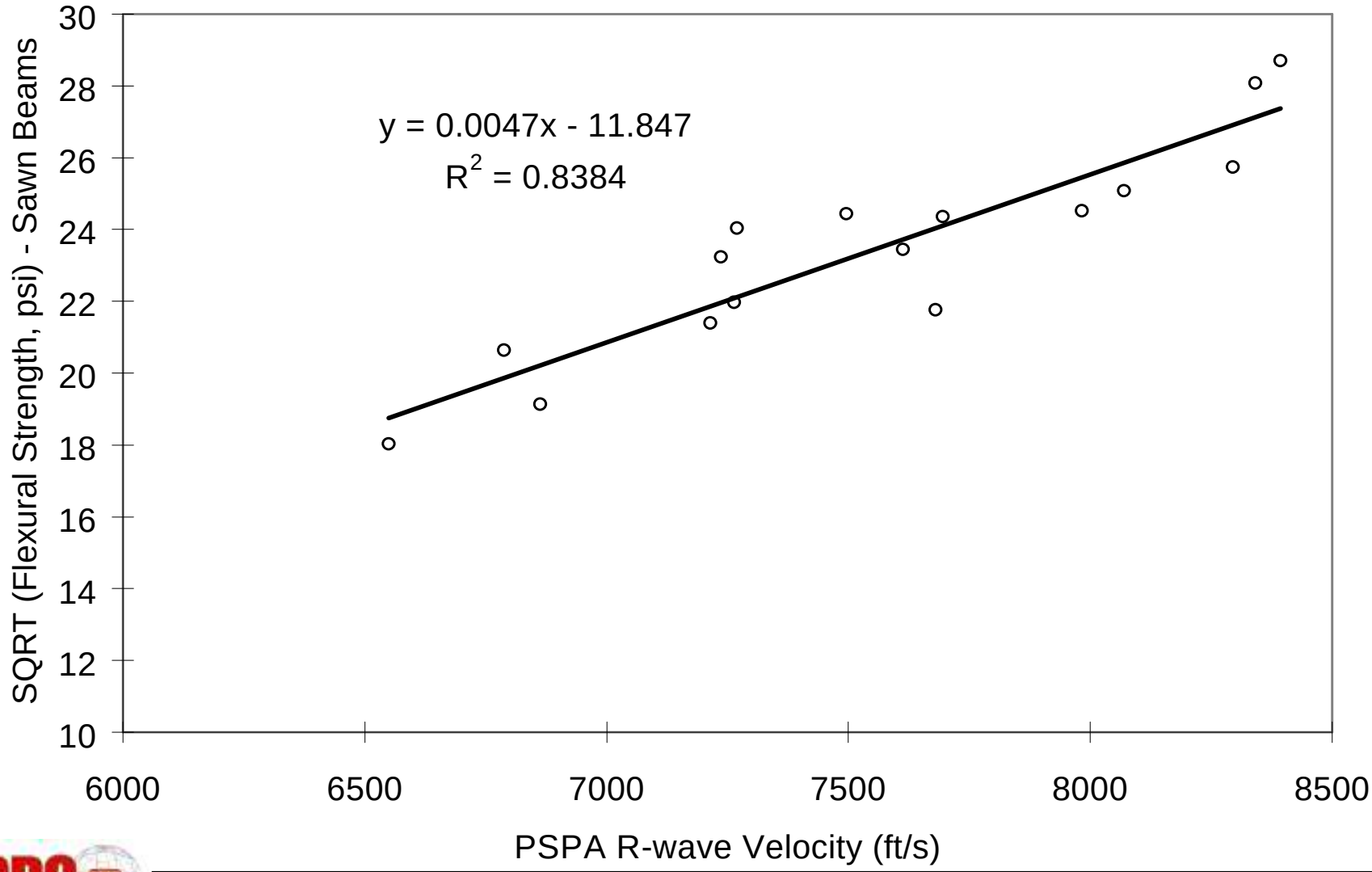


Preliminary Results



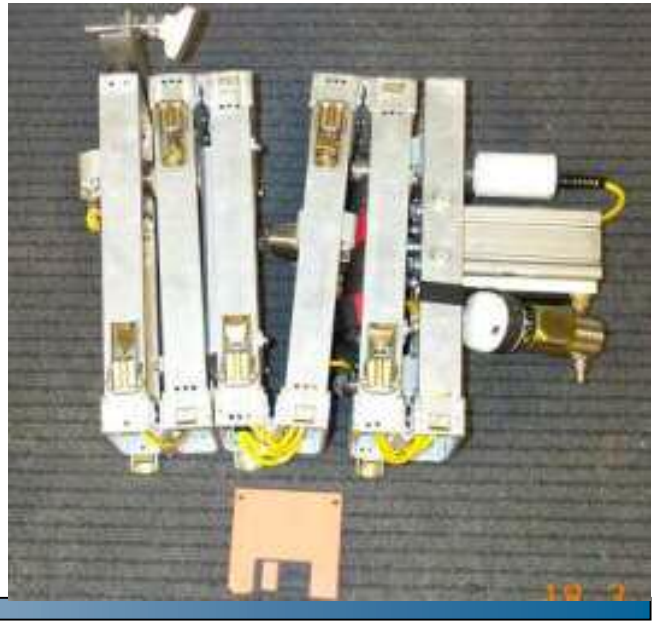
Portable Seismic Pavement Analyzer

PSPA Vs. Flexural Strength



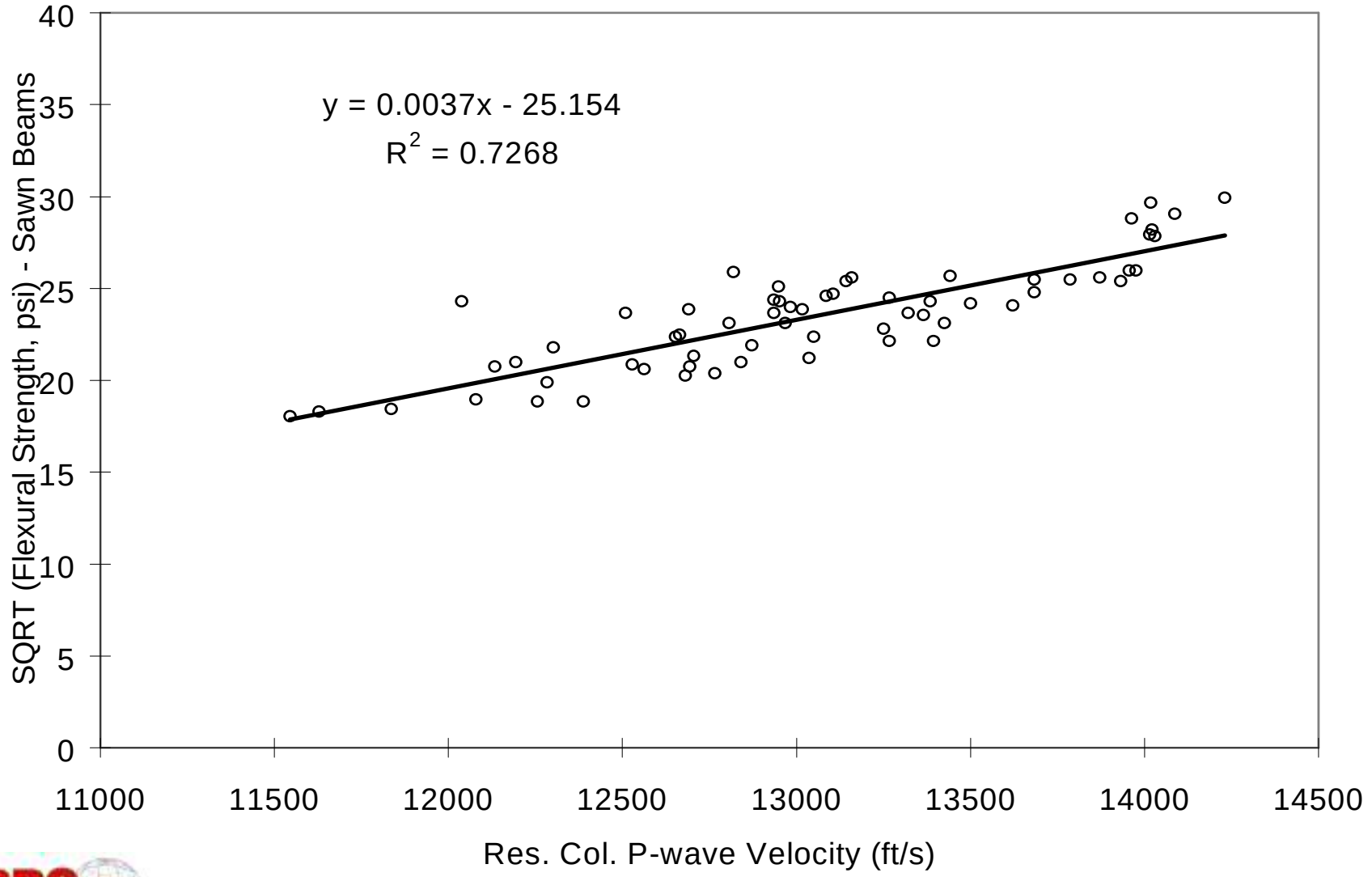
Extended PSPA Under Development

- Partnering With Geomedia (El Paso)
- Folds to Fit into rucksack
- Less than 35 lbs
- Samples to 1-Meter Depth
- Faster and Quieter Than DCP



Free-Free Resonant Column

FF Vs. Flexural Strength (Sawn Beams)



Future

- Army Small Business Innovative Research (SBIR)
  - Stiffness measurement from a moving platform
  - Autonomous data collection systems

Contingency Evaluation Workshop

Questions??